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I. STIGMATOMMA PALLIPES (HALDEMAN)

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During a prolonged study of the cytology of ants, it became evident that in several species there were many interesting anatomical details that seemed worthy of more extended examination. *Stigmatomma pallipes* was one of the first that was noted; and later studied in detail. This led to the collection and preparation of much additional material; eggs, larvae, pupae and adults.

Eventually, more than sixty nearly mature pupae, over one hundred and twenty adult workers, thirty young queens, some fertile, some still virgin, and several queens at least one year old, and also several males were used in this study. All were gathered from a small area near Schenectady. Material from other places was available for comparison with these, but is not included in the following notes. The collections were made at various times from May, 1945, to October, 1955, and included material taken in May, June, August, September and October, in about equal numbers.

Certain tissues are remarkably constant in appearance. For example, the muscles show only slight differences in the many specimens studied; excepting, of course, the differences that distinguished callows from adults of increasing age. In the callows, each muscle is composed of quite slender widely separated strands. In many cases, occasional fat cells occur in the spaces between the strands. In older individuals, the spaces become much smaller and soon disappear completely, the muscle then becoming a fairly solid mass. Another difference that was noted was in cross-stria-

tions of the muscle fibres: in some muscles, these are quite coarse, forming broad bands; in other muscles the bands are much narrower, and less conspicuous; in the flight muscles, the cross-striations are so very fine that the muscles often appear to lack them completely. But none of these is unusual. Nor is the disappearance of the flight-muscles, which in this ant seems to be completed sometime within the year after the nuptial flight, and probably in a much shorter period than that.

The nervous system likewise offers little that seems noteworthy. There are minor variations in the formation of the smaller nerves, in the sequence of their branching; and little more. Nor does the structure of the several ganglia show any conspicuous variation. One fact may be noted—that the nuclei of the cortical tissues of the ganglia do not show any very conspicuous difference in diameter. Seldom does the largest nucleus measure as much as twice that of the smallest one. Nor is the cortical tissue very thick; in many individuals, it is scarcely more than three to four times the diameter of the contained nuclei.

DIGESTIVE SYSTEM. Around the opening of the pocket and extending into the pocket for a short distance, the surface is marked with broad low mounds: across the surface of each mound, there is a row of 6–9 fine spines, progressively shorter from the center to each end of the row; and gradually decreasing in size and in number the farther into the pocket they are. Within, the wall is covered by rather uniformly hexagonal unarmed bosses, separated by shallow grooves. Rarely a specimen was found having the lumen of the pocket quite small. No individual was found with the infrabuccal pocket full. In most, there was a rather small quantity of material, mostly of indeterminate nature. Many individuals had completly empty pockets.

Around the opening of the pharynx, there are numerous densely massed, rather large, outwardly directed spines. Posteriorly, these spines decrease in size and in numbers, especially on the ventral surface, where they soon cease, to be replaced by low transverse ridges. From mid-pharynx posteriorly, the ventral wall is usually quite smooth. The dorsal wall is armed with much stouter spines than those of the ventral wall, and for a greater distance posteriorly. Then they, too, give way to ridges, but here the ridges are much closer together and broader. The ridges of the dorsal wall are 1.5–2μ apart; those of the ventral

wall 3–4.5μ apart. The lining of the oesophagus is entirely smooth, and the wall thin. Externally, there is a layer of longitudinal muscle fibres which are very thin and weak-looking. Surrounding these is an outer layer of circular muscles. The latter are very much coarser than the longitudinal muscles, but are still well separated in rather loose spirals. At times, these seem to be in two layers, one crossing the other in reversed spiral turns. The striations of these outer muscles are very prominent; those of the longitudinal fibres are either completely lacking or so very fine as to be discerned with difficulty. Pl. I, Fig. 2.

In nearly all individuals, the crop was nearly or completely empty, the wall being less than 0.5μ thick and greatly wrinkled, and having many small ellipsoid nuclei measuring $1.5 \times 3.4\mu$. Against the outer surface of this wall, there is usually a layer of rather strong widely separated muscle fibres very irregularly disposed. This muscle layer may decrease both in size and in amount until, in a few individuals, it seems to be completely lacking. This may be clearly seen only in those individuals having crops more or less distended. These muscle strands may measure as much as $2–3 \times 5–5.5\mu$, in transverse section.

The proventriculus is short and rather featureless; the outer layer of circular muscular fibres is very thick, the inner layer of longitudinal muscle fibres is thin and weak. The chitin lining is thin and very irregularly wrinkled, and extends but a very short distance into the stomach.

The stomach wall is composed of columnar cells which in some individuals are quite conspicuously long, with relatively small nuclei. The muscle layers surrounding the stomach are rather thick, especially the outer layer.

There are 9–10 Malpighian tubules, usually about 22–23μ in diameter in the queens, and 14–18μ in the workers.

Little need be said of the intestine and rectum beyond noting that, in nearly all adults, there were little or no contents in the lumen of this part of the alimentary canal. Of 76 individuals noted, 69 had six rectal papillae and seven (two queens, two males, and three workers) had three each. The papillae varied greatly in shape, some being conspicuously rectangular, others uniformly rounded, and in size, the average being 76μ long and 48μ broad.

MANDIBULAR GLAND. Pl. I, Fig. 1. The secretory part of this gland is a small cushion of large cells pressed against the lateral wall of the head. It is separated from the chitin wall only by the cells of the hypodermis. In many specimens, this hypodermis is so thin that the gland cells seem adnate to the inner surface of the chitin wall. There is considerable variation in the number of cells forming the gland and in the size of these cells. One of the smallest found comprised only eight cells and measured about 110μ across and 34μ deep. More commonly, the gland comprises 10–18 cells and measures 85–140μ in diameter and 40–62μ thick. The component cells varied greatly in size and shape, those in the center of the gland being noticeably larger than the lateral cells.

From any point in the apical surface of each gland cell, a single duct extends for a short distance to end by opening through the wall of the gland reservoir. In many specimens, the several ducts come together so that all their openings are massed in a small area; in others, the duct openings are widely separated.

The reservoir of the gland is usually a rather narrow somewhat conical object bounded by a noticeably thick wall in which a few small, thin discoid nuclei occur. Only an occasional specimen shows any contents in the reservoir, and then not enough to reduce appreciably the numerous irregular wrinkles of the reservoir wall. Anteriorly, this part of the gland narrows very gradually until it passes into the base of the mandible, where it turns rather gradually, to end by opening through the wall of the mandible. Details as to the nature of the opening could not be determined, so thick and hard was the chitin.

MAXILLARY GLAND. Pl. I, Fig. 4. This gland seems to be rather small in *Stigmatomma,* and comprises a rather loose group of 8–20 cells near the lateral wall of the infra-buccal pocket. The cells are irregular in shape, but always with rounded outlines, and measure $24 \times 20\mu$ to $41 \times 35\mu$; occasionally, larger dimensions are found when the cells are more irregular. The single nucleus of each cell is spheroidal, less frequently rather irregular, and measures from $7 \times 14\mu$ to $15 \times 18\mu$. Each cell gives rise to a single duct, 0.7–1μ in diameter. The several ducts of each gland join to form a loose irregular strand, and open in a compact group in the lateral wall of the pharynx near the mouth.

PHARYNGEAL GLAND. Pl. I, Fig. 5. This pair of glands, arising from the lateral walls of the posterior end of the pharynx into which it opens, has a quite typical structure. Each gland divides repeatedly to form many branches, some extending forward toward the mouth region, and others posteriorly both above and beside the brain. The latter are often quite long, at times reaching nearly to the posterior border of the brain. The diameter of the branches varies greatly, near its origin being 22–25μ, gradually increasing to 28–40μ in the middle region, and then normally decreasing to a rounded apex where it is 20–24μ in diameter. In an occasional individual, many or even all the branches gradually increase the diameter to the very broad blunt apex which may measure as much as 60μ across. The lumen of the branch varies from 2–5μ in diameter, increase in branch diameter being increase in cell thickness. The lining of the central lumen is always quite smooth.

In nearly all individuals, the central canal appears to be completely empty. Only rarely is an individual found to have obvious secretion in the lumen, seldom enough to cause any evident distension. In only one case, a queen, was there an excessive quantity of secretion—in this queen, the diameter of the branches varied from 80–90μ, the wall thickness varying from 5–14μ. The abundant secretion within had a pale amber color (which may have been due to the stain).

In the workers, the pharyngeal gland normally forms a compact mass in front of the brain, with relatively few branches extending posteriorly above and beside the brain. In the queens, the gland varies more than in the workers, especially in the number of branches and their diameter. In the males, this gland normally has fewer branches, and they are shorter and rather coarse.

LABIAL (SALIVARY) GLANDS. Pl. II, Fig. 1. The secretory portion of this pair of glands occurs in the ventral part of the thorax. It consists of five to eight rather coarse sparingly forked branches which usually form a fairly compact group in the zone between the bases of the first and second pair of legs. One or two shorter branches extend anteriorly. When forking, one lobe of the branch is nearly always much shorter than is the other. The branches are formed of rather irregular, occasionally vacuolate

cells whose lateral walls are usually very vague. The diameter of the branches varies in different individuals from 38–44μ, but is rather uniform in each individual. The central lumen has a diameter of 3–4μ; in rare cases, it may be as small as 2μ.

The several branches of each gland join together very compactly to form the duct of this gland. The two ducts, one on each side, extend anteriorly for some distance and then gradually converge upward and inward near the anterior end of the thorax where they fuse to form a single duct that passes through the head to open in the labium.

This salivary duct (Pl. II, Figs. 1b, c, e) is a very interesting object, and a very variable one in the thoracic portion. It is composed of a central canal whose inner wall is reinforced by annular thickenings. Surrounding this central canal, there is a cellular sheath of varying and variable thickness. Considered externally, this salivary duct seems to be a fairly straight, quite coarse object. Its detailed appearance is quite otherwise, especially the central canal. Only in rare cases is this canal a simple, more or less straight tube. More often, it is thrown into long folds, turning back on itself for distances from one-third to three-quarters of its length. But in very many individuals, this central canal twists and turns in a most bewilderingly irregular manner so that its length becomes several times that of the distance it has to cover; all these convolutions occur within the outer sheath which externally shows none of this, except in its increased diameter. This diameter varies from 7–16μ in the workers; in queens, it may be much larger, even approaching the diameter of the secretory portion in rare cases. The central canal is fairly constant in each individual, and varies from 2.5–7μ, being larger in queens than in workers and males.

The tortuous nature of the central canal continues until the point of fusion of the two sides is reached. From that point on, the canal seems always to be quite straight.

METASTERNAL GLANDS. Pl. II, Fig. 3. This pair of glands has a form apparently rather common in ants. A large somewhat irregular chamber occurs in the posterior portion of the thorax; the posterior and lateral (outer) portion of the wall of this chamber is pressed tightly against the adjacent wall of the thorax and may even be adnate thereto. From the ventral portion of the

chamber, a small somewhat irregular opening gives access to the outside. This opening is quite smooth, as is the entire inner wall of the chamber. The dimensions of the chamber are 120–180 × 80–95μ.

The wall of the chamber is uniformly about 2μ thick over the greater part of its surface. The one area that is thinner is a small, rather irregular patch near the upper and anterior end, where it becomes less than 1μ thick. This is the area through which the many ducts of the secretory cells open into the chamber.

The secretory cells of this gland cover the dorsal surface of the chamber in a loose mass irregularly two to three cells thick; this mass extends down over the anterior and abaxial surface of the chamber to a point well below its mid-region. Near the margins and in the lower portions, this mass of cells is seldom more than a single cell thick.

The cells vary greatly in shape, though usually they are somewhat broadly ellipsoidal, and measure from 26 × 24μ to 32 × 25μ. Cells near the bottom of the mass tend to be noticeably longer and may reach measurements up to 17 × 42μ to 50μ long. Each cell contains a single, nearly spherical nucleus 10–18μ in diameter.

Each cell gives rise to a single duct which passes more or less parallel to the outer surface of the chamber. These ducts form a loose strand which ends in the sieve-like group of pores through the thin area. These ducts are very uniformly 0.8–1.2μ in diameter.

The smallest number of secretory cells noted here was 33, found in a worker. Usually there are three to four times this number of cells. The largest number counted was over 150, in a mature queen.

Occasionally, an individual was found to have numerous very fine "hairs" projecting into the chamber. Evidently these were hardened secretions possibly forced from the ducts by the action of the fixative used.

GASTER GLANDS. Pl. II, Fig. 3. The secretory cells of this pair of glands form a rather irregular mass, sometimes being a single layer of cells just under the dorsal chitin of the fourth gastric segment, but more frequently forming an irregular mass, two to three cells thick. The number of cells varies greatly, being

usually from 25 to 40. Infrequently, individuals are found with only 8–14 cells in each of the glands. The cells vary from nearly spherical and 20–36μ in diameter to slender, elongate cells measuring 36–45 × 10–12μ. Each cell contains a single, usually spherical nucleus 12–15μ in diameter.

From each cell, a duct 0.8–1.2μ in diameter, passes posteriorly to end as a pore through the intersegmental membrane joining the fourth and fifth gastric segments. Each duct enlarges rather abruptly, just before opening through the membrane. These pores may be densely massed in a small area, or may be quite widely separated in a large area of the membrane.

Deeply embedded in the posterior part of the gaster, there is another pair of glands. These are found, one on each side of the sting as it normally rests in the gaster, but slightly dorsal to it and are always formed of a linear series of four to seven rather large rounded cells. From the lower part of each cell, a single duct extends. Each of the rather tortuous ducts pass down and inward, to open through a membrane which is above the sting. An average cell of this gland measures 25 × 16μ; the diameter of the ducts is 0.8–1μ.

Between these glands and slightly anterior to them, there is a tiny structure of three to five minute cells which may be considered as glandular, or as vestiges of a gland. These cells measure 10–12 × 3–4μ. (Pl. II, Fig. 6.)

POISON GLANDS. Pl. II, Fig. 5. The two poison glands are decidedly unequal in size, and in appearance. The larger gland extends diagonally upwards from the base of the sting until near the lower wall of the rectum, where it turns rather abruptly and extends forward to a point approximately above the last gastric ganglion. Throughout its length, there is a gradual increase in diameter until, near its anterior end, it attains a maximum diameter of perhaps 40μ, though in many cases the maximum is much less, even as small as 24μ. Throughout its entire length, this gland is formed of rather narrow columnar cells, each containing a single small spherical nucleus near its outer end. These nuclei vary from 2–3μ in diameter, but are usually of rather uniform size in each individual, being smallest near the posterior end and larger toward the anterior end. The central lumen of this gland varies somewhat, being occasionally of quite uniform

though rather small diameter (2–4μ) : more frequently, it is of very irregular shape, due to the sharply conical inner ends of the wall cells. This gland extends into the base of the sting for some distance, becoming abruptly narrowed and flattened laterally near its end. The opening of this gland is a narrow, transversely elongate slit. Around the opening, the cells become small and very irregular.

In a large majority of the individuals studied, this describes the entire gland, the anterior end being definitely uniformly rounded. However, in some individuals, both workers and queens, two rather conspicuous branches arise from the anterior end. These usually extend forward from 200–400μ, then turn abruptly backward to reach as far back as their origin or even a bit more. Occasionally, there is a second turning so that the final portion extends forward. Now and then, these branches when present are very irregularly contorted, often seeming much entangled.

These branches are composed of large, rather irregular cells, each with a single, usually subspherical, nucleus, 8–11μ in diameter. The diameter of the branches varies from 32–50μ, being usually larger in the queens than in the workers, and varying greatly in any one individual. Only rarely is there even a faint indication of any central lumen.

The second poison gland, the accessory gland, also turns dorsally just anterior to the sting, and then turns sharply toward the rear. It is much shorter than the other gland. The wall of this gland is invariably very irregularly wrinkled in transverse folds and seems to be non-cellular. Not a single nucleus was found in any part of it.

This gland varies greatly in size. In one individual, it ended very soon after its emergence from the base of the sting: in another, it was 220μ long and 14μ in maximum diameter, which is approximately its maximum size. This gland extends into the base of the sting, nearly as far as the first does, and also opens through a transversely elongate slit with closely appressed margins.

REPRODUCTIVE SYSTEM. In the queens, the number of ovarioles in each ovary varies from three to six, with the great majority having four or five in each ovary. In the workers, there are in-

variably either two, or usually three, ovarioles in each ovary. In nearly all the queens studied here, each ovariole contains a series of developing eggs, but the total number is never very large. In most cases, worker ovarioles contain only small egg cells, the largest seldom measuring more than 42μ long, and 28μ in diameter. The number of developing egg cells in workers is always less than that found in the queens. None the less, it would appear that many *Stigmatomma* workers are capable of and may lay small numbers of eggs.

The oviducts and uterus call for little comment, the former being straight thin-walled tubes in both queens and workers, as is also the uterus in many workers. In other workers, the uterus is more like that of the queen, a much wrinkled structure whose dorsal wall is increasingly thicker posteriorly, with the ventral and lateral wall uniformly thin.

The spermatheca of the virgin queen (Pl. II, Fig. 4) has a very constant structure, the wall showing two very distinct areas. In the anterior-dorsal region, there is a large irregularly circular area formed of columnar cells 18–30μ long and about 2.5–3μ in greatest breadth. Each of these cells has a small ellipsoidal nucleus near the outer wall: these nuclei are about 3μ long and 1.5–2.5μ in diameter. The total extent of this part of the wall may be as small as about 1/10 of the total spermathecal surface, but is usually greater than that and in occasional specimens may be about 1/5 the entire surface. The remaining part of the wall is very much thinner and seems capable of considerable change in thickness. In virgin queens, this part is very greatly and irregularly wrinkled. In older queens, after fecundation, the spermatheca expands, the thin portion of the wall then being little or not at all wrinkled.

The spermatheca of the worker differs from that of the queen in having the thickened area very much less extensive, and the thin portion even more wrinkled.

The diameter of the spermatheca varies from 40μ in empty (virgin) queens and in workers, to about 100μ in fertile queens.

The spermathecal duct is rather short and thick-walled, though unequally so, the canal being excentric, the wall of the anterior side measuring 10–17μ and that of the posterior side 3–7μ thick. The canal of the duct is about 2μ in diameter.

The sperm mass seldom completely fills the spermathecal cavity. In it, the sperms are very loosely massed and often appear as if they had been in some sort of swirling movement. No worker has any sperms in the spermatheca.

The spermathecal glands of the queen are ellipsoidal bodies, 44–75μ long and 16–30μ in maximum diameter, rather gradually narrowing towards the posterior end and bluntly rounded at the other end. The wall of the spermatheca is composed mainly of large, irregularly polygonal cells, each with a large spheroidal nucleus 5–7μ in greatest dimension. Toward the center and surrounding the lumen of the gland, there are many small cells with ill-defined walls and small spherical nuclei, 1.5–2.6μ in diameter. In nearly all individuals studied here, the spermathecal glands are above the surface of the uterus, extending anteriorly from the spermatheca. Infrequently, an individual was found with the spermathecal gland extending posteriorly, being then near the upper wall of the spermatheca. The ducts of the spermathecal gland are short and thin-walled. They may pass through the lateral walls of the spermathecal duct to open on opposite sides near the entrance into the spermatheca. In many cases, the two spermathecal gland ducts are found to unite before reaching the spermathecal duct, the single, very short common duct then opening into the anterior wall of the spermathecal duct.

In the workers, the spermathecal glands seem often to be completely lacking; when present, they are much smaller than those in the queen. The spermathecal glands of the workers measure 30–44μ long by 17–23μ in diameter.

The copulatory pouch (Pl. II, Fig. 7) offers little of interest except to note the character of the dorsal wall. In the queens, the dorsal wall of the pouch is armed with uniformly separated, very even transverse rows of 10–18 fine bristles, 3–5μ long in the center and gradually shorter laterally. These bristles are directed posteriorly. Where this wall turns upward, back of the spermatheca, the spines cease, the wall surface being then characterized by flat-topped, somewhat irregular hexagonal bosses, about 1μ high. The opposite (ventral) wall of the pouch is quite smooth.

MANDIBLE. Four tissues pass from the head into the mandible: the ligaments of the rather large muscles that move the mandibles, one or two rather small trachea, two nerves and the now quite

narrow chamber of the mandibular gland. This chamber turns almost at once in the base of the mandible, upward and inward to open through an irregular pore in the mandible wall. The exact shape of this pore could not be determined. Of the two nerves, one is conspicuously larger than the other. This larger nerve passes along the lower part of the mandible, just above the hypodermal layer. From the large nerve, two types of branches occur. Most conspicuous are several quite large branches that pass to the upper surface of the mandible, where each branch passes into one of the several rather coarse teeth found there. Within these teeth, the nerve branches spread apart to form loose bundles of fine nerve fibres. These branches measure 35–80μ in maximum breadth. The numerous nuclei occurring in these branches are always ellipsoidal and measure 2.5–4μ in diameter, and 6–12μ in length. Less conspicuous and more numerous are the many fine nerves that branch off from all sides to enter the fine canals through the chitin wall, and to pass into the bases of the smaller hairs that occur on the mandible surface. In addition to these nerve canals, the mandibular wall is traversed by numerous minute pores, 0.3–0.5μ in diameter.

Fat cells and oenocytes are also present in the cavity of the mandible.

ANTENNAE. (Pl. I, Fig. 6.) *Stigmatomma pallipes* is not the most favorable ant to use for a study of the finer details of the antenna; for the chitin is not only heavily pigmented and thick, 12–15μ, but also very brittle. Despite which, fairly satisfactory results were obtained in the course of this study.

The scape offers little difficulty, being of quite simple structure. Two slender muscles extend from near its base to the outer end, where they are modified to ligaments that extend into the pedicel. A small tracheal tube passes lengthwise through the scape as do two relatively large nerves. Infrequently, fine nerve fibres branch off from the nerves and pass diagonally to the hypodermal layer, and presently end at, or in the bases of the few slender hairs that occur on the scape. Occasional fat-cells appear here also.

The flagellum is much more interesting structurally. Two nerves pass through this structure, sending off several small branches in each joint. The trachea also extends throughout the length of the flagellum, with frequent irregular branches occurring in each segment.

The nerve branches pass laterally to be lost in masses of small spherical nuclei, 1–2μ in diameter. From 30 to 60 of these occur in each of the many irregularly ellipsoidal masses that line the walls of the segments rather uniformly. Within or at the base of each of these groups, there are from 4–6 larger nuclei. From the outer end of each group, a slender bundle of fine nerve fibres passes diagonally toward the chitin wall, where it enters one of the many canals that pass outward toward the external surface. It was seldom possible to follow these fibres to their final end, but apparently this is in one of the many hairs that occur on the surface, or in the modified structures that are found there.

The surface of the antennae bears several types of hairs: some are coarse, straight and abruptly blunt-tipped; others are long, tapering slender hairs standing out from the surface; still others are abruptly angled at the base so that they are closely pressed against the surface; and finally, there are very fine pointed, slender hairs which are much shorter than any of the others. Arising from the groups of small nuclei, slender nerve fibres pass, each through a canal and into the base of one of the hairs. These hairs occur on all segments of the flagellum.

On the apical segment, two other structures occur. The first of these, styled champagne-cork organs by Forel, (Pl. I, Fig. 6d, e.) are contained within rather coarse canals through the wall. From an area about mid-way through the wall, a thin layer of chitin folds back a bit and then again outward, to end in three rather slender pointed teeth, entirely free from the wall of the canal. Across the base of this structure, a thin chitin film stretches, its center raised into a low, rather blunt, papilla. Three rather coarse groups of nerve fibres extend up to this surface: exactly how they end could not be determined in this study, perhaps because of the nature of the chitin surfaces involved.

Above this structure, the canal extends upward to the chitin surface, narrowing rather gradually, to form a very thin incomplete membrane—incomplete, because there is always a small circular opening in its center.

There are always 6–9 of these organs in the apical segment, most of them in the outer half. Those most distant from the apex of the segment differ slightly from the others, in having the thin apical surface sink abruptly inward to form a short cylindrical tube. The entire organ varies from 7–10μ in its

maximum diameter. Two to four of these organs also occur in the subapical segment.

Yet another structure occurs in the apical segment, the flask-shaped organs, also named by Forel. (Pl. I, Fig. 6c.) In *Stigmatomma,* these are limited to the outer third of a rather narrow sector of this segment, and are about twelve in number. Each organ comprises a cylindrical base, 5–8μ in diameter and 20–26μ long, narrowing rather sharply at its conical upper end to a slender irregularly bent tube 0.7–1.1μ in diameter. Each tube passes into the base of a canal through the chitin wall, and comes to an end near the mid-point of the canal. In some of these organs, the tube has a uniform diameter throughout its length; in others, that portion of the tube which is within the canal enlarges gradually to 3–4 times its average diameter. The basal portion of this organ usually has its rounded end at right angles to its length, but occasional examples are at a decided angle; some are even quite irregular. Extending the length of this basal portion, there is a central canal about 2μ in diameter; this canal narrows gradually at the upper end of the basal portion of the organ and continues as an extremely fine canal through the entire length of the narrow portion.

The apex of the ultimate segment of the antenna gradually narrows to become a rather stout spine, the apical end of which is bluntly rounded. (Pl. I, Fig. 6g, h.) Cross sections show that four small canals extend through this spine; but these do not appear to open through the apex. Well below the base of this spine, a group of four to six relatively large nuclei occurs. From these nuclei, a narrowing bundle of nerve fibres extends up and into the base of these spines.

In addition to the canals associated with all these organs, the chitin wall of the joints of the flagellum is traversed by many irregularly distributed fine pores, scarcely 0.1μ in diameter. (Some of these are shown in transverse section in Pl. I, Fig. 6d).

PUPAE. Many pupae were included in the collections on which these notes are based. Of these, over sixty were nearly mature, the wall formation of the adult form being well advanced, with head, thorax, and abdomen clearly distinct, and nearly all the internal organs well formed. These were examined in some detail. The most noticeable condition found was the occasional

occurrence of an individual with certain organs out of place. Most frequently noted were individuals having the crop entirely in the thorax, the proventriculus then extending from the posterior thorax through the isthmus and into the gaster. Less frequently noted were individuals having both crop and proventriculus in the thorax; two pupae studied had all three, crop, proventriculus, and stomach in the thorax; the intestine appeared to be tautly stretched and very narrow in one individual; the intestine and rectum shared equally in the tautness in the second case. The most extreme case noted was one with the crop and proventriculus in the head, the stomach partly in the head and partly in the anterior half of the thorax, and narrowly constricted where it passed through the neck; the intestine of this individual extended through the rest of the thorax and into the gaster, where the greatly narrowed rectum stretched nearly the full length of the gaster, the six rectal papillae occurring in the zone of the second gastric segment.

Similar to the foregoing were several individuals in which the reproductive organs were out of place. In several queen pupae, the ovaries were entirely in the thorax, usually in the posterior half. In two individuals, the ovaries were in the anterior end of the thorax, the oviduct then being a very slender tube reaching straight back to the posterior part of the gaster, where the spermatheca was found in its normal position.

Male pupae also shared in such abnormalities, several being observed to have the testes entirely in the thorax; and one extreme case showed a part of the testes in the head, where it was behind and above the brain.

Whether these displaced organs would have been eventually established in their proper positions is a question that cannot be answered here. Possibly many of those abnormal individuals would perish before eclosion. It would appear that not all suffer this fate, for several adults were found to have the entire crop or a considerable part of that organ in the thorax; one adult insect was noted to have the entire crop and much of the proventriculus in the thorax.

One further abnormality is to be noted: an adult queen having what can only be the larval silk gland still present in the head, where it occurred as a much contorted coarse unbranched tube, its lumen filled with yellowish secretion.

SUMMARY

Over one hundred and twenty workers, thirty young and some quite old queens, as well as sixty nearly mature pupae and a few males were studied in detail. The collections extended through ten years, covering the entire growing season. Attention is centered on variations within this ant, rather than in comparisons with other ants. Differences between callows and older workers are noted briefly, as well as differences between various muscles, including the flight muscles. The nervous system is quite constant, the cortex being very thin. The digestive system is described briefly, but shows no variations of particular note.

The several major glands are described in detail, with particular attention to the duct of the labial gland, it being very variable, and to the poison glands. In the latter, the larger gland is found to present two aspects, one characterized by having two quite long branches from the anterior end, the other lacking them completely. The significance of this could not be determined.

The reproductive system is described briefly, attention being centered on the spermatheca and its glands, since these varied slightly.

Extreme irregularity in pupation is described, it being found in many specimens that one or more of the parts of the digestive system are present in the developing thorax when they would normally appear in the gaster. Cases are also found with the ovaries in the thorax. A few adults are also noted to have some organs out of place.

DESCRIPTION OF FIGURES

All figures are drawn with the aid of a camera lucida. Two scales are given, the 25μ scale measures all detail figures, the 200μ scale measures the other figures. Plate II, Fig. 1 is an outline figure of a diagrammatical section through the thorax, the labial gland being shown at the left, and the metasternal at the right. This figure is at a much smaller scale than all the others.

Plate I. Fig. 1. The mandibular gland, showing chitin wall, hypodermis, the edge of secretory cells. *a*. Detail of secretory cells, one with duct, and above, detail of wall and hypodermis, and edge of secretory cells. *b*. Detail of wall of reservoir near its anterior end. *c*. Transverse section of part of reservoir wall. Fig. 2. Longitudinal sections of thoracic portion of oesophagus: right, tangential section showing large encircling muscles; left, slightly lower section, showing transverse sections of encircling muscles, and finer longitudinal muscles. Fig. 3. Hypodermis and chitin layer of callow adult (above) and old adult worker (below). Fig. 4. The maxillary gland, with outline of transverse section of half of pharynx and the infrabuccal pocket. *a*. Details of secretory cells and ducts. Fig. 5. Details of the pharyngeal gland, showing portions of gland near its opening, and an apical part of two ultimate branches of gland, one narrow, the other quite broad. Fig. 6. The antenna. *a*. Transverse section of the subapical segment, showing the chitin wall, the groups of small nuclei and the two nerves. Surface hairs are omitted. *b*. Longitudinal section of last two segments, showing these same parts, and also two of the flask-shaped organs. *c*. Detail of flask-shaped organ, with some of the surrounding nuclei, large ones above, and small ones beside it. *d*. Detail of transverse section of champagne-cork organ, together with some of the minute pores through the chitin wall. *e*. Details of longitudinal section of champagne-cork organs from base (above) and apex (below) of apical segment. The dark circles above the upper one are groups of small nuclei. *f*. Detail of transverse section through nuclei of nervous elements associated with large apical spine. *g*. Detail of longitudinal section of apical spine, and the large nuclei and nerve fibres associated with it. *h*. Details of sections through the large apical spine from base to apex.

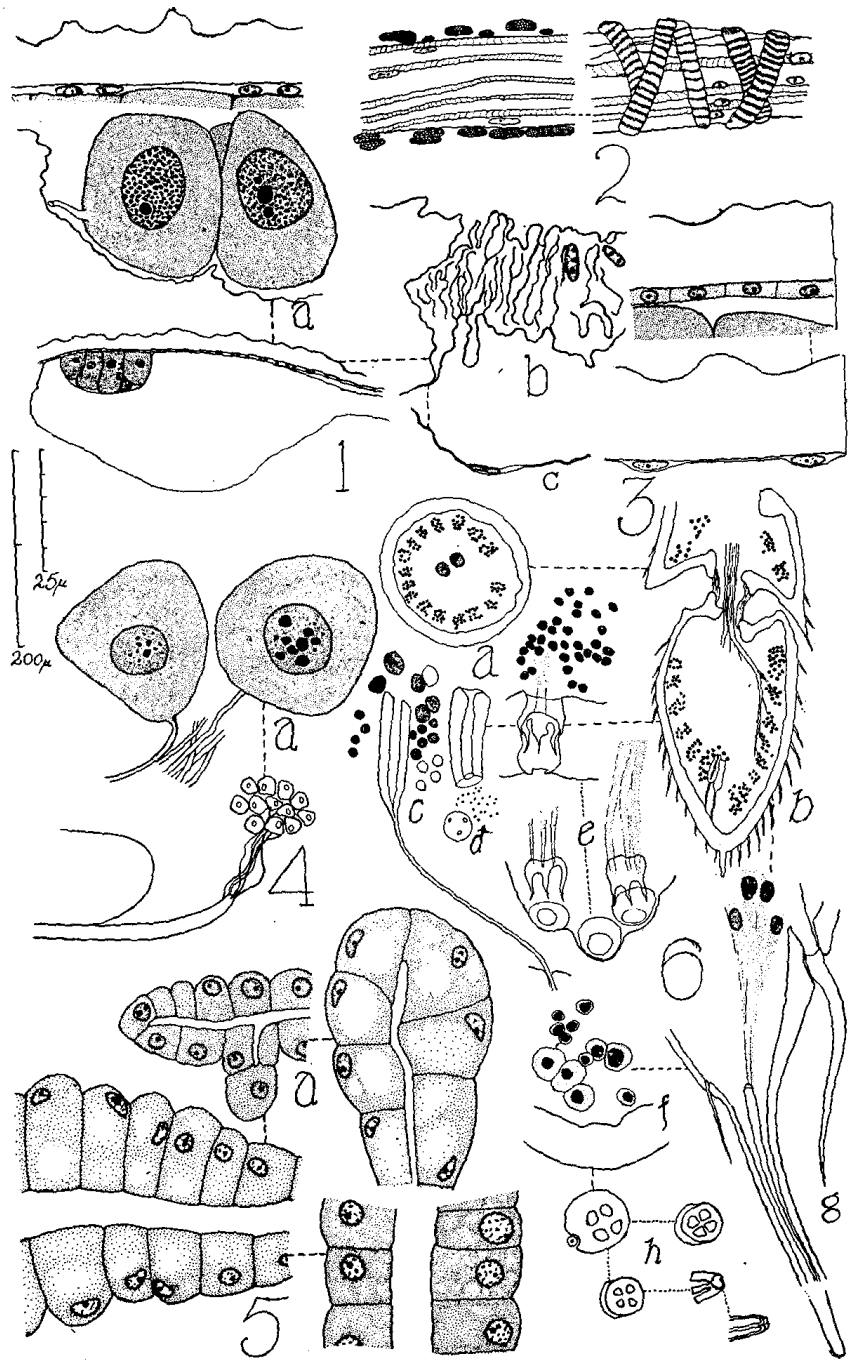
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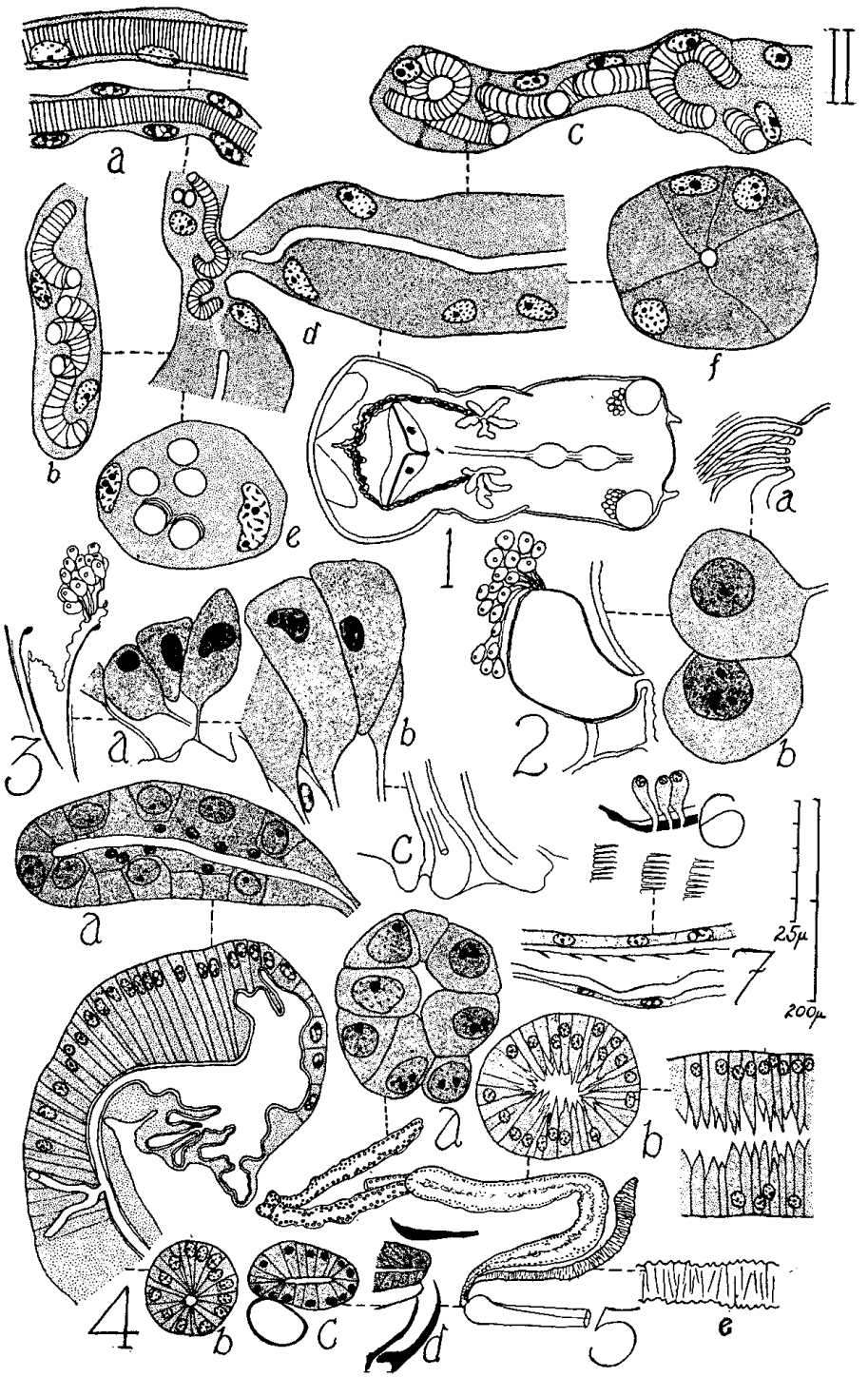
Plate II. Fig. 1. Diagrammatic section of thorax, showing labial gland at left and metasternal gland at right. *a*. Details of the labial gland duct in the head. *b*. Detail of duct in anterior thorax, near point of junction with that of the opposite side. *c*. Detail of duct near secretory portion, showing very irregular twisting of central canal. *d*. Detail of junction of duct with the bases of two of the secretory branches. *e*. Detail of transverse section of duct in thorax, showing sections of five loops of the canal. *f*. Detail of transverse section of secretory branch. Fig. 2. The metasternal gland, showing the irregular chamber and part of secretory portion. *a*. Detail of duct openings. *b*. Detail of secretory cells. Fig. 3. The gaster gland, showing intersegmental membrane between fourth and fifth gastric segments. *a*. Detail of secretory cells of an adult male. *b*. Detail of secretory cells of a queen. *c*. Detail of some of the duct openings of a queen. Fig. 4. The spermatheca, in longitudinal section, with part of its duct, and common opening of the spermathecal gland ducts. *a*. Detail of spermathecal gland showing two sets of nuclei and central lumen. *b*. Detail of transverse section of spermathecal duct, with excentric canal. Fig. 5. The poison glands, showing part of sting below, the two glands and one of apical branches sometimes present in this gland. *a*. Detail of transverse section of one of these apical branches. *b*. Detail of transverse (at left), and longitudinal (at right) sections of the same gland, showing irregular central lumen. *c*. Detail of transverse section of the two glands as they enter the base of the sting. *d*. Detail of longitudinal section of the ends of these glands in the sting. (The black outlines are parts of chitin of the sting.) *e*. Detail of a portion of the second (accessory) poison gland. Fig. 6. Minute gland in gaster. Fig. 7. Copulatory pouch, showing the spine-bearing dorsal surface with the adjoining hypodermal layer and the smooth ventral surface and its hypodermis. Above this is a detail of the rows of spines occurring on the dorsal surface.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